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TITLE: Wireless Communication Apparatus, Wireless Communication System, and Wireless Communication Method

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SIR;

CERTIFIED TRANSLATION

I, Kaname SAITO, am an official translator of the Japanese language into the English language and I hereby certify that the attached comprises an accurate translation into English of Japanese Application No. 2003-001177, filed on January 7, 2003.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

April 23, 2008 Kaname Saito

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[TITLE OF THE INVENTION] WIRELESS COMMUNICATION APPARATUS, WIRELESS COMMUNICATION SYSTEM, AND WIRELESS COMMUNICATION METHOD

[CLAIMS]

[Claim 1]

A wireless communication apparatus communicating with another wireless communication apparatus comprising:

a frame period setting means for setting a predetermined frame period common to all the wireless communication apparatus;

a data slot setting means for setting slots serving as data transmission units;

a reception slot setting means for setting at least one reception slot for receiving a signal in said frame period.

a transmitting means for transmitting a beacon signal to another wireless communication apparatus at a predetermined timing of the frame period, which beacon has information about a timing of the reception slot set by the reception slot setting means; and

a receiving means for receiving a signal which is transmitted by another wireless communication apparatus.

[Claim 2]

A wireless communication apparatus as set forth in

claim 1, wherein the receiving means receives signal at a timing of the reception slot set by the reception slot setting means.

[Claim 3]

A wireless communication apparatus for communicating with another wireless communication apparatus comprising:

a frame period setting means for setting a predetermined frame period common to all the wireless communication apparatus;

a data slot setting means for setting slots serving as data transmission units;

a scan period setting means for setting any scan period longer than said frame period;

a scanning means for receiving a beacon signal transmitted from another wireless communication apparatus over a time of said frame period unit;

a managing means for converting the timing of said received beacon signal and the timing of the reception slot into its own slot positions and managing the same; and

a transmitting means for transmitting a signal at the timing of the reception slot of the corresponding wireless communication apparatus when a communication directed to another wireless communication apparatus is

performed.

[Claim 4]

A wireless communication apparatus as set forth in claim 3, further comprising a control means for storing the timing of the beacon signal and the timing of the reception slot from the other wireless communication apparatus, and, when there is a data directed to the other wireless communication apparatus, performing a reception at the timing of the reception slot of the corresponding wireless communication apparatus.

[Claim 5]

A wireless communication system for communication among a plurality of wireless communication apparatuses, wherein

each of the wireless communication apparatuses comprises:

a frame period setting means for setting a predetermined frame period common to all the wireless communication apparatus;

a data slot setting means for setting slots serving as data transmission units;

a beacon slot setting means for setting beacon slots for transmitting beacon signals at a predetermined timing of said frame period;

a reception slot setting means for setting at

least one reception slot for the receiving operation in said frame period;

a transmitting means for transmitting a beacon signal which has information about a timing of a reception slot set by said reception slot setting means and informing its presence to another wireless communication apparatus in the neighborhood;

a scan period setting means for setting any scan period longer than said frame period; and

a managing means for performing scan processing for continuous reception over a time of said frame period unit and receiving a beacon signal of another wireless communication apparatus in the neighborhood and managing the timing of receiving said beacon signal and the timing of the reception slot.

[Claim 6]

A wireless communication method for communication among a plurality of wireless communication apparatuses , wherein each wireless communication apparatus

sets a predetermined frame period common to all the wireless communication apparatus and slots serving as data transmission units,

sets at least one beacon slot for transmitting the beacon signal at a predetermined timing of the frame period and reception slot for the receiving operation in

the frame period, and

transmits a beacon signal which has information about the timing of the set reception slot and informs its presence to another wireless communication apparatus located in the neighborhood.

[Claim 7]

A wireless communication method as set forth in claim 6, wherein each wireless communication apparatus performs reception process at a timing of the reception slot set and receives a data transmitted from another wireless communication apparatus.

[Claim 8]

A wireless communication method for communication among a plurality of wireless communication apparatuses, wherein each wireless communication apparatus

sets a frame period common to all the wireless communication apparatus and slots serving as data transmission units,

provides any scan period longer than the frame period, performs scan processing for continuous reception over the time of the frame period unit,

receives a beacon signal transmitted from another wireless communication apparatus located in the neighborhood, and

manages the timing of the reception of the beacon

signal and the timing of the reception slot.

[Claim 9]

A wireless communication method as set forth in claim 8, wherein each wireless communication apparatus stores the timing of the beacon signal and the timing of the reception slot from the other wireless communication apparatus, and, when there is a data directed to the other wireless communication apparatus, performs reception at the timing of the reception slot of the corresponding wireless communication apparatus.

[Claim 10]

A wireless communication method for communication among a plurality of wireless communication apparatuses, at each wireless communication apparatus, comprising the steps of:

setting a predetermined frame period common to all the wireless communication apparatus and slots serving as data transmission units,

setting at least one beacon slot for transmitting a beacon signal at a timing of the head of said frame period and a reception slot for a receiving operation in said frame period,

transmitting a beacon signal which has information about the timing of the set reception slot and, notifies existence to another communication apparatus located in

the neighborhood,

setting any scan period longer than said frame period and performing scan processing for continuous reception over the time of said frame period unit, and

-eceiving a beacon signal of another wireless communication apparatus in the neighborhood and managing the timing of receiving said beacon signal and the timing of the reception slot.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention]

The present invention relates to a wireless communication apparatus, a wireless communication system, and a wireless communication method employing a time division multiplex connection method based on asynchronous control of the respective communication apparatuses in an autonomous distributed network.

[0002]

[Prior Art]

At present, the method of administration by direct communication by terminal stations without arranging a base station in a network like an ad hoc mode of a wireless local area network (wireless LAN) based on the IEEE802.11 standard is known.

[0003]

Further, in recent years, as a technology enabling data communication at a close distance at an ultra-high speed, unlike a communication system which has conventionally used a certain specific carrier, ultra-wide band wireless communication for transmitting information carried on a very short pulse sequence is attracting attention.

This ultra-wide band wireless communication can directly and wirelessly transmit a baseband signal, so enables a simple circuit configuration and is mentioned as a strong candidate for a personal area network assuming a data transmission rate of about 100 Mbps.

[0004]

Further, as a conventional time division multiplex connection method, as used in mobile phone and other systems, the method of arranging a base station in the network and making all moving terminal stations perform time divisional multiplex connections in synchronization with signals from the base station is generally known.

[0005]

And, in order for a plurality of apparatuses to simultaneously engage in above explained ultra-wide band communications, the method of time division multiplex connection has generally been considered.

Further, in order to form a wireless network among

a plurality of apparatuses, the method of arranging a control station referred to as a "coordinator" at the center of the network and utilizing central management by the control station for time division multiplexing of time for which a plurality of apparatuses engage in ultra-wide band communication is generally known (IEEE802.15.3).

[0006]

[Problem to be Solved by the Invention]

In the recently hot ultra-wide band communication, however, an extremely weak pulse sequence was used for communication, so there was the disadvantage that easy configuration of the means for detecting the carrier which had been utilized in the conventional wireless system was difficult.

[0007]

Further, in the conventional ad hoc mode of a wireless LAN, it was not necessary to establish synchronization among all terminals, but there was the disadvantage that a means for detecting the carrier was necessary before transmitting information so as to prevent collision with communication of other terminals. Accordingly, the technology cannot be utilized for wireless communication.

[0008]

Further, when using a plurality of terminals operating in the ad hoc mode of a wireless LAN to form a network, since it was not known when information would arrive from another terminal, it was necessary to constantly operate to be ready to receive signals, therefore there was the disadvantage that reduction of the power consumption was difficult.

[0009]

Further, when operating in the ad hoc mode, since other apparatuses were not constantly synchronized with, there was the disadvantage that time division multiplex communication was difficult when a plurality of communication links repeatedly transferred information in a predetermined period.

[0010]

In conventional mobile phone and other time division multiplex communication systems, in order to avoid collision of slots divided in time, all terminals in the system had to be synchronized with the base station, so it was necessary to mount sophisticated mechanisms enabling all terminal stations to synchronize with the base station.

[0011]

Further, when communicating by time division multiplexing in a conventional wireless network, it was

necessary to arrange a control station referred to as a "coordinator" at the center of the network and have the control station centrally manage operations.

[0012]

A first object of the present invention is to provide a wireless communication apparatus, a wireless communication system, and a wireless communication method enabling any plurality of apparatuses to engage in time division multiplex communication for a plurality of data communications even without all apparatuses inside the network correcting synchronizing.

[0013]

A second object of the present invention is to provide a wireless communication apparatus, a wireless communication system, and a wireless communication method enabling easy time division multiplex communication when any communication apparatuses form a network ad hoc.

[0014]

A third object of the present invention is to provide a wireless communication apparatus, a wireless communication system, and a wireless communication method enabling access control without arranging a specific control device in ultra-wide band wireless communication.

[0015]

A fourth object of the present invention is to

provide a wireless communication apparatus, a wireless communication system, and a wireless communication method enabling a receiving operation only when required without always engaging in a receiving operation and accordingly enabling easy reduction of the power consumption.

[0016]

[Means for Solving the Problem]

To attain the above objects, a first aspect of the present invention is a wireless communication apparatus communicating with another wireless communication apparatus comprising a frame period setting means for setting a predetermined frame period common to all the wireless communication apparatus; a data slot setting means for setting slots serving as data transmission units; a reception slot setting means for setting at least one reception slot for receiving a signal in the frame period; a transmitting means for transmitting a beacon signal to another wireless communication apparatus at a predetermined timing of the frame period, which beacon has information about a timing of the reception slot set by the reception slot setting means; and a receiving means for receiving a signal which is transmitted by another wireless communication apparatus.

[0017]

Preferably, the receiving means receives signal at

a timing of the reception slot set by the reception slot setting means.

[0018]

A second aspect of the present invention is a wireless communication apparatus for communicating with another wireless communication apparatus comprising a frame period setting means for setting a predetermined frame period common to all the wireless communication apparatus; a data slot setting means for setting slots serving as data transmission units; a scan period setting means for setting any scan period longer than the frame period; a scanning means for receiving a beacon signal transmitted from another wireless communication apparatus over a time of the frame period unit; a managing means for converting the timing of said received beacon signal and the timing of the reception slot into its own slot positions and managing the same and; a transmitting means for transmitting a signal at the timing of the reception slot of the corresponding wireless communication apparatus when a communication directed to another wireless communication apparatus is performed .

[0019]

Preferably, it further comprises a control means for storing the timing of the beacon signal and the timing of the reception slot from the other wireless

communication apparatus, and, when there is a data directed to the other wireless communication apparatus, performing a reception at the timing of the reception slot of the corresponding wireless communication apparatus.

[0020]

A third aspect of the present invention is a wireless communication system for communication among a plurality of wireless communication apparatuses, wherein each of the wireless communication apparatuses comprises a frame period setting means for setting a predetermined frame period common to all the wireless communication apparatus; a data slot setting means for setting slots serving as data transmission units; a beacon slot setting means for setting beacon slots for transmitting beacon signals at a predetermined timing of the frame period; a reception slot setting means for setting at least one reception slot for the receiving operation in the frame period; a transmitting means for transmitting a beacon signal which has information about a timing of a reception slot set by said reception slot setting means and informing its presence to another wireless communication apparatus in the neighborhood; a scan period setting means for setting any scan period longer than said frame period; and a managing means for

performing scan processing for continuous reception over a time of said frame period unit and receiving a beacon signal of another wireless communication apparatus in the neighborhood and managing the timing of receiving said beacon signal and the timing of the reception slot.

[0021]

A fourth aspect of the present invention is a wireless communication method for communication among a plurality of wireless communication apparatuses , wherein each wireless communication apparatus sets a predetermined frame period common to all the wireless communication apparatus and slots serving as data transmission units and sets at least one beacon slot for transmitting the beacon signal at a predetermined timing of the frame period and reception slot for the receiving operation in the frame period, transmits a beacon signal which has information about the timing of the set reception slot and informs its presence to another wireless communication apparatus located in the neighborhood.

[0022]

Preferably, in the wireless communication apparatus, a reception process at a timing of the reception slot set is performed and a data transmitted from another wireless communication apparatus is receives.

[0023]

A fifth aspect of the present invention is a wireless communication method for communication among a plurality of wireless communication apparatuses, wherein each wireless communication apparatus sets a frame period common to all the wireless communication apparatus and slots serving as data transmission units, provides any scan period longer than the frame period, performs scan processing for continuous reception over the time of the frame period unit, receives a beacon signal transmitted from another wireless communication apparatus located in the neighborhood, and manages the timing of the reception of the beacon signal and the timing of the reception slot.

[0024]

Preferably, the communication apparatus stores the timing of the beacon signal and the timing of the reception slot from the other wireless communication apparatus, and, when there is a data directed to the other wireless communication apparatus, performs reception at the timing of the reception slot of the corresponding wireless communication apparatus.

[0025]

A sixth aspect of the present invention is a wireless communication method for communication among a plurality of wireless communication apparatuses, at each

wireless communication apparatus, comprising the steps of: setting a predetermined frame period common to all the wireless communication apparatus and slots serving as data transmission units, setting at least one beacon slot for transmitting a beacon signal at a timing of the head of the frame period and a reception slot for a receiving operation in the frame period, transmitting a beacon signal which has information about the timing of the set reception slot and notifies existence to another communication apparatus located in the neighborhood, setting any scan period longer than the frame period, performing scan processing for continuous reception over the time of the frame period unit, and receiving a beacon signal of another wireless communication apparatus in the neighborhood and managing the timing of receiving said beacon signal and the timing of the reception slot.

[0026]

According to the present invention, by providing a frame period common to all apparatuses, dividing the frame to slots of further shorter time units, setting at least one beacon slot to be periodically transmitted at a timing of the head of the frame period set by itself and a reception slot received by itself, writing the position of the reception slot in the beacon information and transmitting the beacon, and thereby notifying another

apparatus located at the neighborhood.

Further, each apparatus provides any scan period with a period longer than the frame period. When that period passes, it engages in a receiving operation over the frame period, receives the beacon from an apparatus located at the neighborhood, and confirms the apparatus located at the neighborhood.

Then, each apparatus repeatedly and periodically engages in reception processing when the timing of the reception slot arrives.

At least one reception slot may be provided in the frame period, but a plurality of reception slots can be provided according to the need of the apparatuses as well.

When transmitting data to a certain apparatus, the invention transmits data at the timing of the position of the reception slot written in the beacon signal from a surrounding apparatus from which a signal can be received by the scanning.

The apparatus receiving the data can employ a configuration also capable of handling large capacity data communication by addition of a reception slot whenever addition becomes necessary.

[0027]

[Embodiment of the Invention]

Below, embodiments of the present invention will be

explained with reference to the attached drawings.

[0028]

FIG. 1 is a view of an example of the arrangement of communication apparatuses configuring a wireless communication system according to the present invention.

[0029]

A wireless communication system 10 of the example of FIG. 1 shows a case where there are eight wireless communication apparatuses 11 to 18.

Namely, FIG. 1 shows the situation where the wireless communication apparatus 11 to the wireless communication apparatus 18 are distributed in the same space.

Further, in FIG. 1, the communication ranges of the wireless communication apparatuses 11 to 18 are indicated by broken lines. These are defined as ranges where not only is communication with other wireless communication apparatuses within those ranges possible, but also where signals transmitted by oneself cause interference.

[0030]

In the wireless communication system 10 of FIG. 1, the wireless communication apparatus 11 is in a range capable of communicating with the neighboring wireless communication apparatuses 12, 13, and 17.

The wireless communication apparatus 12 is in a

range capable of communicating with the neighboring wireless communication apparatuses 11 and 13.

The wireless communication apparatus 13 is in a range capable of communicating with the neighboring wireless communication apparatuses 11, 12, and 15.

The wireless communication apparatus 14 is in a range capable of communicating with the neighboring wireless communication apparatus 15.

The wireless communication apparatus 15 is in a range capable of communicating with the neighboring wireless communication apparatuses 13, 14, and 16.

The wireless communication apparatus 16 is in a range capable of communicating with the neighboring wireless communication apparatuses 15 and 18.

The wireless communication apparatus 17 is in a range capable of communicating with the neighboring wireless communication apparatus 11.

The wireless communication apparatus 18 is in a range capable of communicating with the neighboring wireless communication apparatus 16.

[0031]

Further, the wireless communication system 10 according to the present embodiment employs an access control method where the wireless communication apparatuses 11 to 18 utilize one wireless transmission

channel in a time division manner while considering interference with other wireless communication apparatuses around them.

[0032]

FIG. 2 is a view of the configuration of a frame period and the configuration of a scan period employed in a wireless communication system according to the present embodiment.

[0033]

In the present embodiment, as shown in FIG. 2, a beacon slot (S0: BSLT) for transmitting the beacon at a predetermined timing and data slots (S1 to S255: DSLT) for receiving the data are arranged. A total of 256 slots together form a frame period FLMP. A frame period FLMP is set at for example 30 ms to 40 ms.

This frame period FLMP is provided with a scan frame SCNF and a normal frame NRMF. Each wireless communication apparatus is configured to perform a scan operation for obtaining a grasp of the existence of a surrounding wireless communication apparatus in a scan frame SCNF.

32 frames of this scan frame SCNF (F0) and normal frames NRMF (F1 to F31) together form the scan period SCNP.

Note that the parameters of the number of slots and

the number of frames indicated here are numerical values set for convenience and are not limited to the numerical values indicated here.

[0034]

FIG. 3(A) to (E) are views concretely showing a series of operations of the wireless communication system 10 of FIG. 1 by time series.

Here, these show operations in the wireless communication apparatus 13 at the position of FIG. 1 in comparison with the communication apparatuses 11, 12, and 15 located at its periphery.

FIG. 3(A) shows the communication state of the wireless communication apparatus 11; FIG. 3(B) shows the communication state of the wireless communication apparatus 12; FIG. 3(C) shows the communication state of the wireless communication apparatus 15; and FIG. 3(D) and FIG. (E) show the concrete operation state of the wireless communication apparatus 13.

Note that, in FIG. 3(A) to (E), BCN indicates a beacon, RSLT indicates a reception slot, CNTRCV indicates continuous reception, SCNO indicates a scan operation, and DRCV indicates data reception. Further, FLMP indicates a frame period. SCNF indicates a scan frame, SCNP indicates a scan period, and t indicates the time.

[0035]

As shown in FIG. 3(D) and (E), the wireless communication apparatus 13 transmits the beacon BCN in the frame period FLMP set in advance, engages in a continuous receiving operation (CNTRCV) in the scan period SCNF set in advance, and engages in a scan operation (SCNO).

At this time, it receives the beacon signal of the wireless communication apparatus 12, the beacon signal of the wireless communication apparatus 11, and the beacon signal of the wireless communication apparatus 15 located at its periphery as shown in FIG. 3(A) to (C).

It can obtain a grasp of the reception slot RSLT set by each wireless communication apparatus by these beacon signals.

The wireless communication apparatus 13, as shown in FIG. 3(A) to (D), arranges its own reception slot RSLT 13 at a position not colliding with the reception slots RSLTs of these wireless communication apparatuses 11, 12, and 15 at its periphery and transmits the setting status by the next beacon information BCN13 transmitted by itself to the surrounding wireless communication apparatuses 11, 12, and 15.

By performing a series of operations for each scan period FLMP, it is possible to arrange the slot for transferring data while obtaining a grasp of the

existence of surrounding wireless communication apparatuses.

[0036]

Here, this wireless communication apparatus 13 can receive data from the other wireless communication apparatuses 11, 12, and 15 located at the neighborhood by receiving data at the timing of the reception slot set by itself.

Further, when it is necessary to transmit data toward the other communication apparatuses 11, 12, and 15, this wireless communication apparatus 13 can engage in a transmitting operation of data matching the timing of the reception slot of the destination wireless communication apparatus so as to transmit data without collision with communication from other wireless communication apparatuses.

[0037]

Below, an explanation will be given of a concrete example of the configuration of a wireless communication apparatus according to the present embodiment.

[0038]

FIG. 4 is a view of the configuration of an embodiment of a wireless communication apparatus according to the present invention.

The wireless communication apparatuses 11 to 18 of

FIG. 1 have the same configuration, so the wireless communication apparatuses are represented by the notation 100 here.

[0039]

This wireless communication apparatus 100, as shown in FIG. 4, has a time counting portion 101, a frame managing portion 102, an information storage portion 103, an interface 104, a transmission buffer 105, a slot managing portion 106, a reception buffer 107, a beacon generating portion 108, a beacon analyzing portion 109, a wireless transmitting portion 110, a timing control portion 111, a wireless receiving portion 112, and an antenna 113.

Note that for example the frame managing portion 102 configures the frame period setting means and the scan period setting means, and the slot managing portion 106 and the beacon generating portion 108 etc. configure the reception slot setting means.

[0040]

The time counting portion 101 includes for example a counter, counts times of the frame period FLMP common to all apparatuses and the scan period SCNP, etc. and outputs the counting result to the frame managing portion 102.

[0041]

The frame managing portion 102 sets the frame period FLMP set by this wireless communication apparatus 100 and its start time and the scan period SCNP.

[0042]

The information storage portion 103 stores the information of the beacon transmission position and the reception slot position of the wireless communication apparatus located at the neighborhood under the management of the slot managing portion 106.

[0043]

The interface 104 becomes the input/output terminal between a not illustrated application device connected to this wireless communication apparatus 100 and the transmission buffer 105 and reception buffer 107.

[0044]

The transmission buffer 105 stores the information to be transmitted from the application device connected via the interface 104.

When receiving a data transmission request via the interface 104 when transmitting data, the transmission buffer 105 notifies the information including the destination information of the data to the slot managing portion 106.

[0045]

The slot managing portion 106 designates the

reception slot of this wireless communication apparatus 100 and the slot for transmission directed to the other wireless communication apparatuses.

The slot managing portion 106 fits the timing information from individual wireless communication apparatuses to the slots of its own frame period FLMP and stores the same as the timing information of the wireless communication apparatuses located at its own neighborhood in the information storage portion 103.

[0046]

The reception buffer 107 stores the information wirelessly received for delivering the information to the application device connected.

[0047]

The beacon generating portion 108 generates the identifier of this wireless communication apparatus 100 and the set reception slot as a beacon signal based on an instruction of the slot managing portion 106.

[0048]

The beacon analyzing portion 109 analyzes the timings of the beacons and the reception slots from the received beacon signals and outputs the analysis results to the slot managing portion 106.

[0049]

The wireless transmitting portion 110 modulates the

beacon and the transmission data to be transmitted to convert them to a wireless transmission signal and emits the wireless signal through the antenna 113 to the transmission medium (air) at the timing designated by the timing control portion 111.

[0050]

The timing control portion 111 designates the transmission timing in the wireless transmitting portion 110 by the instruction of the slot managing portion 106 and designates the timing for reception in the wireless receiving portion 112.

[0051]

The wireless receiving portion 112 receives the signal sent from the other wireless communication apparatus via the antenna 113 at the predetermined timing designated by the timing control portion 111.

[0052]

The antenna 113 emits the wireless signal from the wireless transmitting portion 110 into the transmission medium (air), receives the wireless signal from the transmission medium (air), and supplies the same to the wireless receiving portion 112.

[0053]

The wireless communication apparatus 100 having the above configuration receives a notification from the time

counting portion 111 when the scan period arrives. The frame managing portion 102 notifies the reception of a whole frame to the slot managing portion 106. The slot managing portion 106 issues an instruction to the timing control portion 111 and thereby makes the wireless receiving portion 112 operate over the predetermined time.

The beacon signals received at the wireless receiving portion 112 are analyzed in the beacon analyzing portion 109, then information of the timings of the beacons and the timings of the reception slots of the wireless communication apparatuses is notified to the slot managing portion 106.

The slot managing portion 106 fits the timing information from these individual wireless communication apparatuses to the slots of its frame period FLMP and stores the same as the timing information of the wireless communication apparatuses located at the neighborhood in the information storage portion 103.

[0054]

Further, when transmitting a beacon, the frame managing portion 102 delivers an instruction for transmitting the beacon at the timing of the head of the frame to the slot managing portion 106. The slot managing portion 106 requests the generating portion 108 to generate the beacon signal and notifies the timing of its

own reception slot to the timing control portion 111.

The beacon generating portion 108 generates a beacon signal writing the position of its own reception slot.

Then, the timing control portion 111 transfers an instruction for wireless transmission to the wireless transmitting portion 110 when the timing of the head of the frame arrives, whereupon the wireless transmitting portion 110 transmits the beacon via the antenna 113.

[0055]

When transmitting data, first the transmission buffer 105 receives a data transmission request via the interface 104 and notifies information including the destination information of the data to the slot managing portion 106.

The slot managing portion 106 refers to the timing of the reception slot of the destination wireless communication apparatus from the storage information of the information storage portion 103. If the reception slot is set, it sends the timing to the timing control portion 111.

And, when the timing of the predetermined slot arrives, the timing control portion 111 transfers the instruction for wireless transmission to the wireless transmitting portion 110. Due to this, the wireless

transmitting portion 110 transmits the data to be transmitted via the antenna 113.

[0056]

When receiving data, first the slot managing portion 106 notifies the timing of its own reception slot to the timing control portion 111 which then makes the wireless receiving portion 112 operate at the timing of the reception slot.

The data signal received at the wireless receiving portion 112 is stored in the reception buffer 107. The data is delivered to an application device connected to the wireless communication apparatus 100 via the interface 104 at the predetermined timing when constant data can be correctly collected.

[0057]

FIG. 5 is a view of an example of the configuration of the beacon information according to the present embodiment.

[0058]

This beacon information 200 may be configured by information distinctive to a wireless communication apparatus such as a communication apparatus address (CMADR) 201 like a MAC address, beacon period information (BPI) 202 indicating the beacon transmission period of this wireless communication apparatus, reception slot

information (RSN) 203 representing the timing set as the reception slot, and further, according to need, the reception slot information.

It is provided with a reservation region (RSV) 204 until the predetermined information length and a CRC 205 for detecting the error added to the tail.

Note that here, for convenience, the general value of the length of each information is additionally shown.

In FIG. 5, the communication apparatus address (CMADR) 201 is indicated as 6 bytes, the beacon period information (BPI) 202 is indicated as 1 byte, and the reception slot information (RSN) 203 is indicated as 1 byte.

[0059]

FIG. 6 is a view of an example of the configuration of the data information according to the present embodiment.

[0060]

This data information 300 is comprised of MAC header information (HDI) 301 including for example the destination address information, a data payload (DPLD) 302 as the content of the data to be transmitted, and a CRC 303 for detecting error added to the tail.

Note that here, for convenience, the general value of the length of each information is additionally shown.

In FIG. 6, the data payload (DPLD) 302 is envisioned as having a capacity of about 1500 bytes as a size by which an IP packet can be transmitted well.

[0061]

Next, the series of operations of the wireless communication apparatus 100 having the above configuration will be explained with reference to the flow chart of FIG. 7.

[0062]

First, after the power is turned on, the wireless communication apparatus 100 sets its own frame period FLMP and beacon transmission position (ST1) and also sets the scan period SCNP (ST2).

Then, it sets the scan time over the frame period FLMP (ST3) and enters into the beacon receiving operation (ST4).

Here, if receiving beacons, the received positions (timings) are calculated and recorded from the beacon reception positions (timings) and the reception slot information written in those beacons (ST5).

On the other hand, when it is decided at step ST4 that no beacons were received, the routine shifts to the processing of step ST6.

At step ST6, it is decided whether or not the scan time has passed. If the scan time has not passed, the

routine returns to the processing of step ST4. If the scan time has passed, the routine shifts to the processing of step ST7.

Further, the apparatus sets its own reception slot so as to avoid collision with the reception slot positions of these other wireless communication apparatuses and writes this as the beacon information (ST7).

Then, the apparatus decides whether or not the timing of the transmission position of the beacon (head of frame) has arrives (ST8) and transmits the beacon signal only when the timing arrives (ST9).

[0063]

The reception processing at one's own reception slot decides whether or not its own reception slot has arrived (ST10), activates the wireless receiving portion 112 when the reception slot arrives, and engages in the reception processing (ST11).

Here, it decides whether or not data directed to itself has been received (ST12). If received, it stores the data in the reception buffer 107 (ST13), then the routine shifts to the processing of step ST14. At this time, when receiving beacons of other wireless communication apparatuses at this time, it may engage in the beacon reception processing.

The routine shifts to the processing of step ST14 both when the reception slot does not arrive in the decision of step ST10 and also when data directed to itself was not received in the decision of step ST12.

[0064]

The transmission processing for transmitting data decides whether or not a data transmission request was received by the transmission buffer 105 via the interface 104 (ST14).

It then acquires address information of the destination wireless communication apparatus based on the request (ST15).

Then, it decides whether or not the reception slot information of the wireless communication apparatus corresponding to the address is registered (ST16) and sets the transmission at that timing when registered.

That is, it decides whether or not the timing of the reception slot of the corresponding wireless communication apparatus has arrived (ST17) and performs the data transmission processing only when the timing has arrived (ST18). Then, the routine shifts to the processing of step ST19.

Here, even when the decision of step ST14 is that there is no data transmission request and the reception slot of the corresponding wireless communication

apparatus is not registered, the routine shifts to the processing of step ST19.

[0065]

At step ST19, it decides whether or not the scan period set at step ST2 has arrived. When it has not arrived, the routine shifts to the processing of step ST8, where it transmits the beacon at the timing for periodically transmitting the beacon and engages in the receiving operation for the reception slot.

Further, when the scan period arrives, the routine shifts to the processing of step ST3, where it performs the scan operation for obtaining a grasp of the existence of the surrounding wireless communication apparatuses again.

[0066]

As explained above, according to the present embodiment, as the time division multiplex connection method of an autonomous distributed network, a continuous receiving (scan) operation over a frame period is performed so that each wireless communication apparatus can obtain a grasp of the wireless communication apparatuses located at the neighborhood at predetermined periods, beacon signals from other wireless communication apparatuses are received to obtain a grasp of the wireless communication apparatuses communicable with, the

reception slot of the wireless communication apparatus from the received beacon information is calculated, a reception slot so as not to collide with the set situation thereof is set, and a net work where the time division multiplex communication with other wireless communication apparatuses located at the neighborhood is autonomously engaged is formed, so there is the advantage that time division multiplex connection method by asynchronous control of communication apparatuses in the autonomous distributed network can be easily realized.

[0067]

Further, by providing a frame period common to all apparatuses, dividing the frame to slots of further shorter time units, and communicating in units of the slots, it is possible to communicate with a high random accessability on a wireless transmission channel while forming an ad hoc network without synchronization with the surrounding apparatuses.

Further, by providing a frame period common to the wireless communication apparatuses and periodically transmitting beacons at the timing of the head of the frame period, all wireless communication apparatuses can obtain a grasp of the existence of the other wireless communication apparatuses located at their neighborhood.

Further, by periodically transmitting beacons in

the frame period set by each apparatus and setting at least one reception slot for reception by a communication apparatus, it is possible to utilize other regions for communication of the other apparatuses and possible to improve the repeat utilization efficiency of a wireless transmission channel.

Further, by providing any scanning period in each apparatus and performing continuous reception (scanning) in units of frame periods, it is possible to obtain a grasp of other apparatuses located at the neighborhood.

Further, even if deviation occurs in the operating clock with other apparatuses, by ignoring the past scan information and making the newest scan information valid, communication is possible without regard as to clock deviation with other apparatuses.

From the above, a wireless communication system and wireless communication method for communicating without among a plurality of apparatuses requiring clock correction can be realized.

[0068]

[Effect of the Invention]

As explained above, according to the present invention, there is an advantage that it is possible to communicate with a high random accessability on a wireless transmission channel while forming an ad hoc

network without synchronization with the surrounding apparatuses.

Further, all wireless communication apparatuses can obtain a grasp of the existence of the other wireless communication apparatuses located at their neighborhood.

[0069]

Further, by periodically transmitting beacons in the frame period set by each apparatus and setting at least one reception slot for reception by a communication apparatus, it is possible to utilize other regions for communication of the other apparatuses and possible to improve the repeat utilization efficiency of a wireless transmission channel.

Further, by providing any scanning period in each apparatus and performing continuous reception (scanning) in units of frame periods, it is possible to obtain a grasp of other apparatuses located at the neighborhood.

[0070]

Further, even if deviation occurs in the operating clock with other apparatuses, by ignoring the past scan information and making the newest scan information valid, communication is possible without regard as to clock deviation with other apparatuses.

[0071]

From the above, a wireless communication system and

wireless communication method for communicating without among a plurality of apparatuses requiring clock correction can be realized.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1]

A view of an example of the arrangement of communication apparatuses configuring a wireless communication system according to the present invention.

[Fig. 2]

A view of the configuration of a frame period and the configuration of a scan period employed in a wireless communication apparatus according to the present embodiment.

[Fig. 3]

(A) to (E) are charts concretely showing a series of operations of the wireless communication system of FIG. 1 in a time series.

[Fig. 4]

A view of the configuration of an embodiment of a wireless communication apparatus according to the present invention.

[Fig. 5]

A view of an example of the configuration of beacon information according to the present embodiment.

[Fig. 6]

A view of an example of the configuration of data information according to the present embodiment.

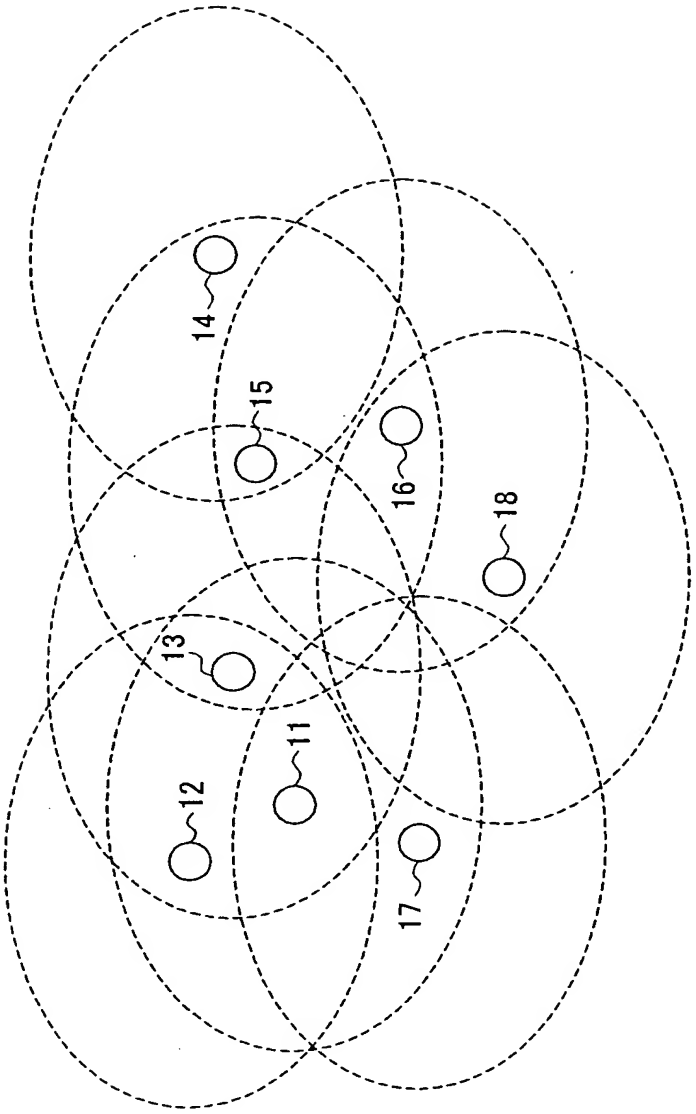
[Fig. 7]

A flow chart for explaining a series of operations of a wireless communication apparatus according to the present embodiment.

[Description of References]

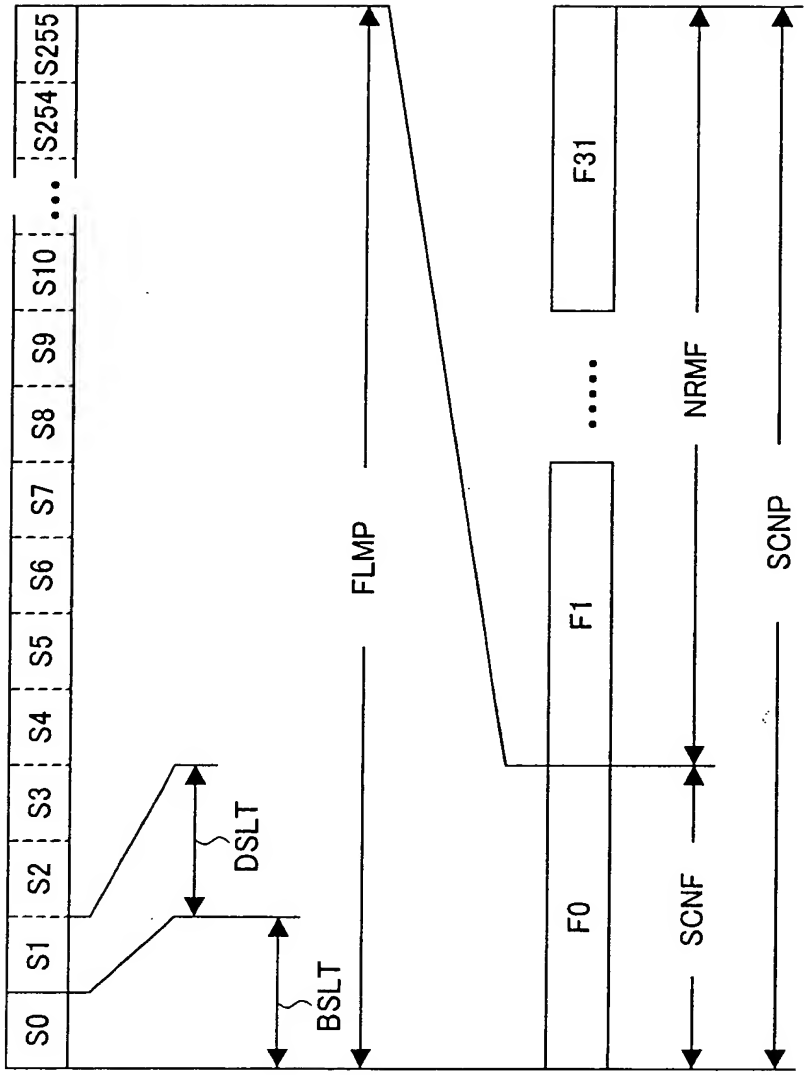
10... wireless communication system, 11 to 18, 100... wireless communication apparatus, 101... time counting portion, 102... frame managing portion, 103... information storage portion, 104... interface, 105... transmission buffer, 106... slot managing portion, 107... reception buffer, 108... beacon generating portion, 109... beacon analyzing portion, 110... wireless transmitting portion, 111... timing control portion, 112... wireless receiving portion, 113... antenna, FLMP frame period, SCNP... scan period, BLST... beacon slot, DSLT... data slot, SCNF... scan frame, NRMF... normal frame, BCN... beacon, RSLT... reception slot, 200... beacon information, 201... communication apparatus address (CMADR) , 202... beacon period information (BPI) , 203... reception slot number (RSN) , 204... reservation region (RSV) , 205... CRC, 300... data information, 301... MAC header information (HDI) , 302... data payload (DPLD) , 303... CRC

[NAME OF DOCUMENT] DRAWINGS
[FIG. 1]



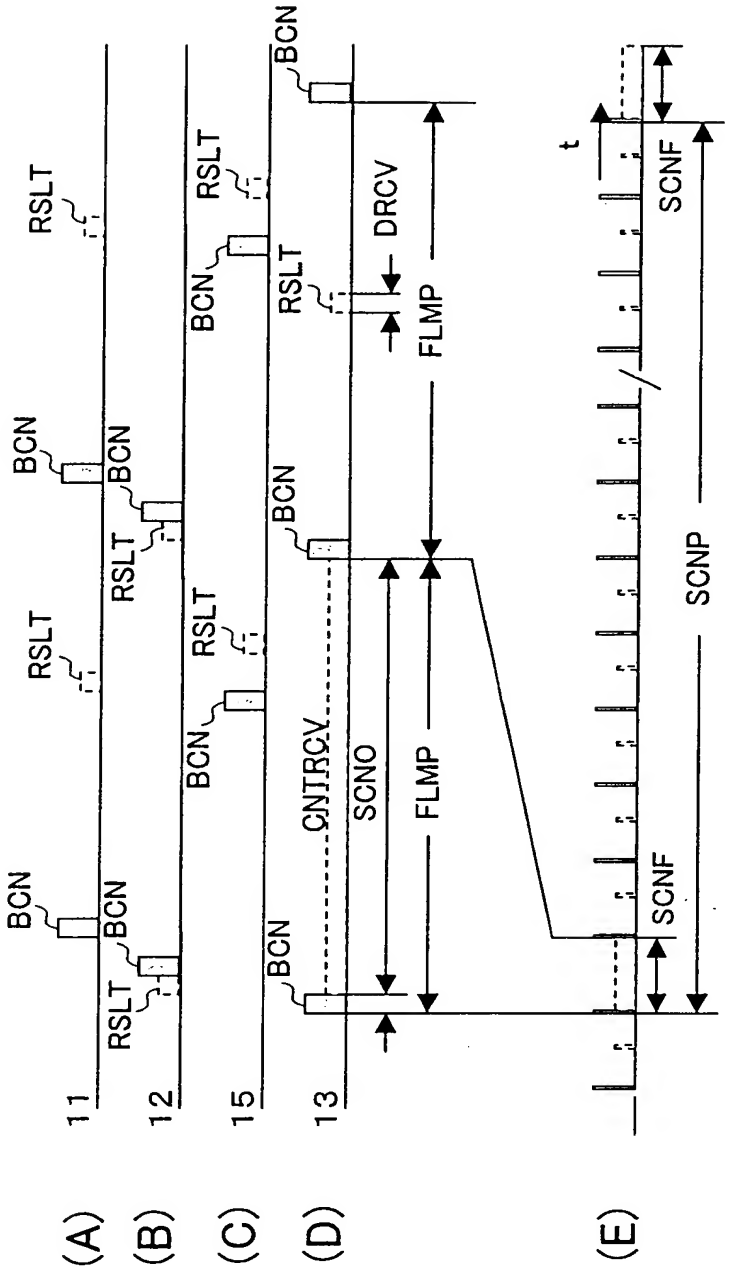
[FIG. 2]

S04P0040



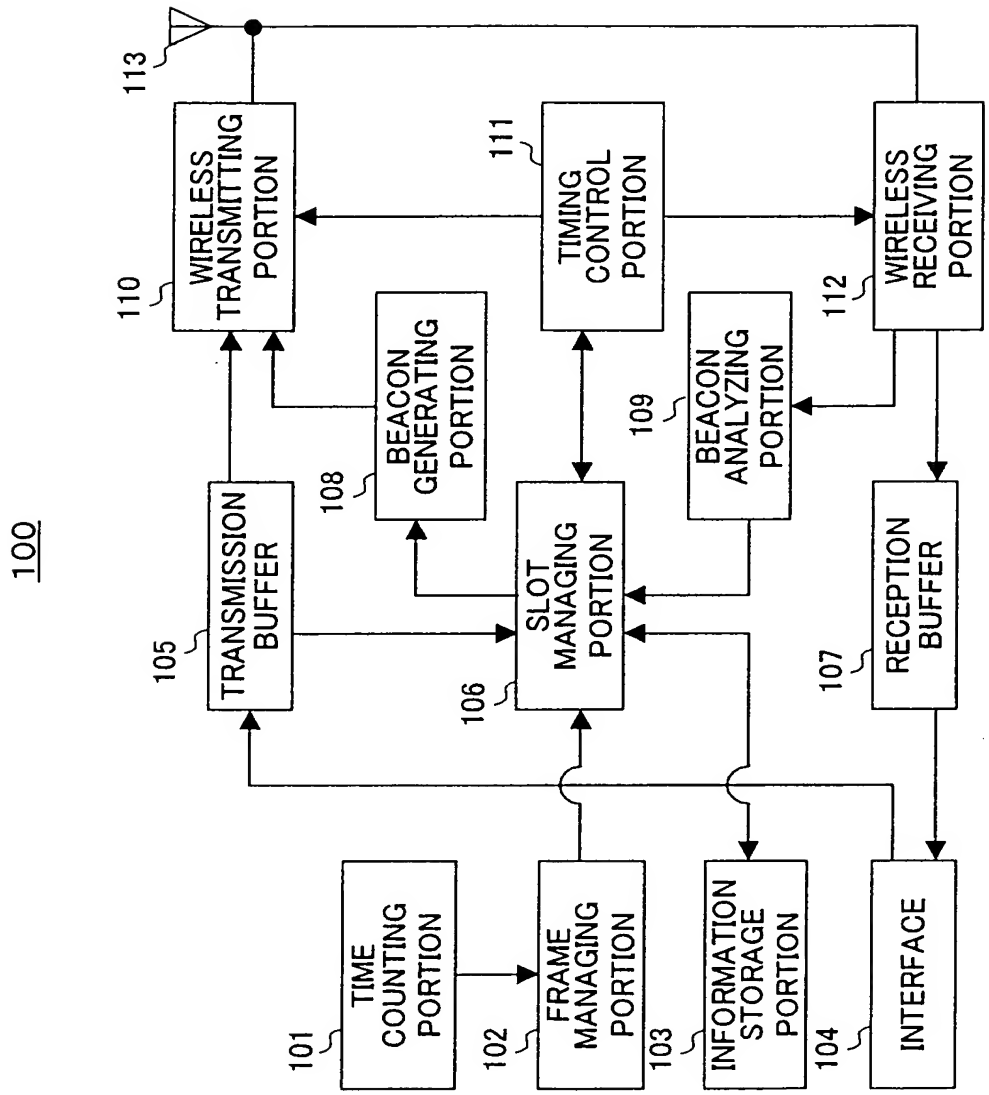
[FIG. 3]

S04P0040



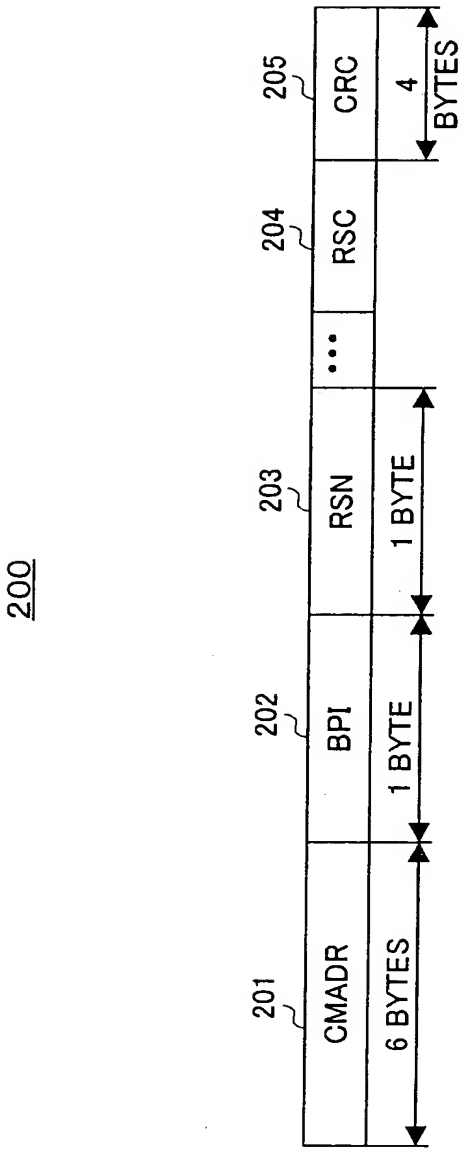
[FIG. 4]

S04P0040

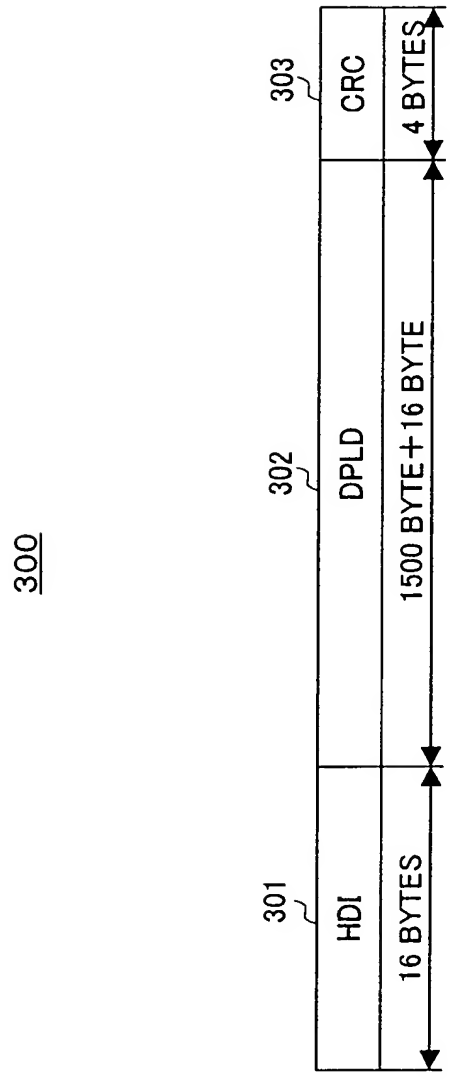


[FIG. 5]

S04P0040

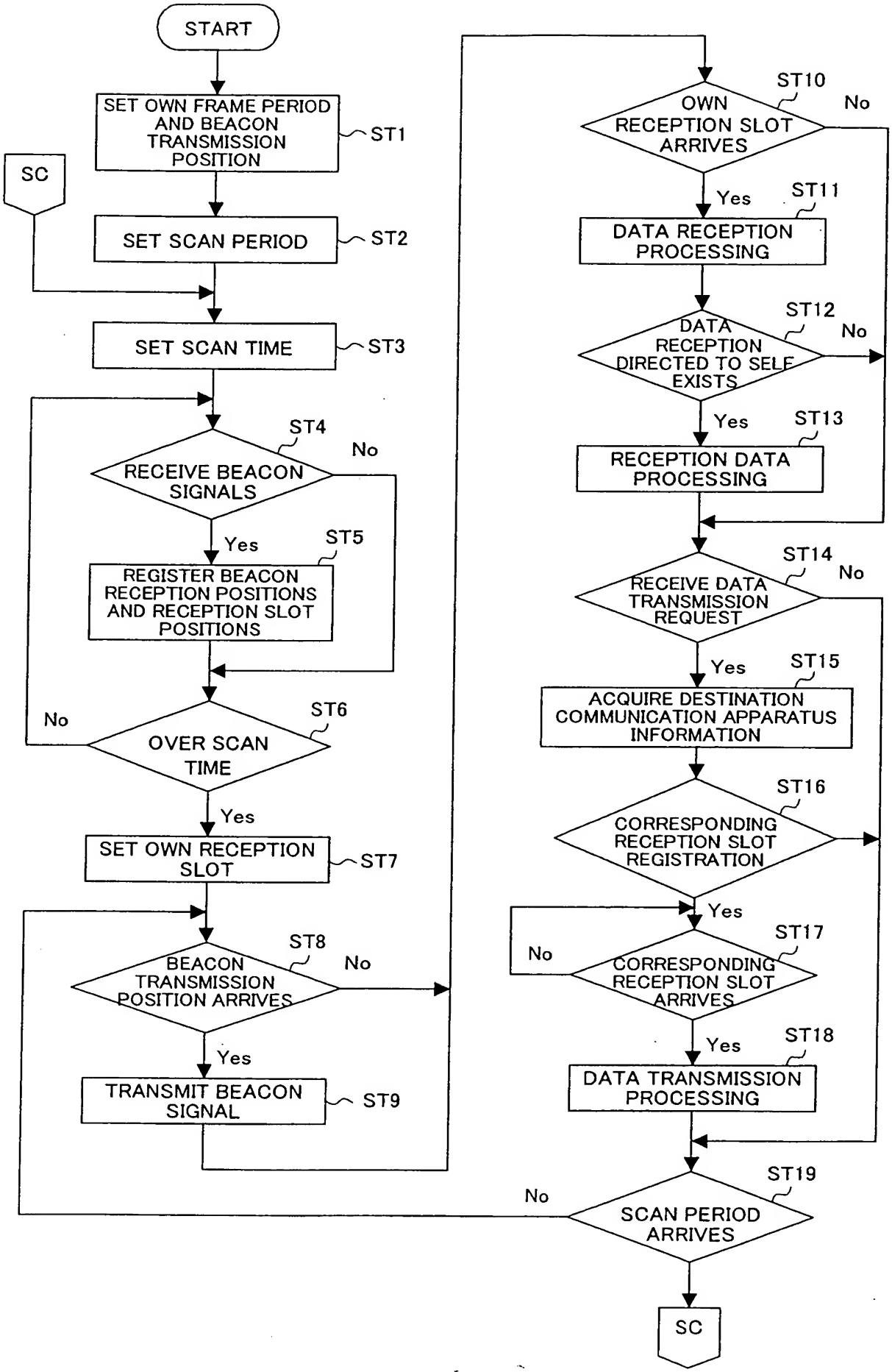


[FIG. 6]



[FIG. 7]

S04P0040



[NAME OF DOCUMENT] ABSTRACT

[ABSTRACT]

[PROBLEM] To provide a wireless communication apparatus, a wireless communication system, and a wireless communication method enabling any plurality of apparatuses to engage in time division multiplex communication for a plurality of data communications even without all apparatuses inside the network correcting synchronizing

[MEANS FOR SOLUTION] As the time division multiplex connection method of an autonomous distributed network, a net work which performs a continuous receiving (scan) operation over a frame period (ST1 to ST3) so that each wireless communication apparatus can obtain a grasp of the wireless communication apparatuses located at the neighborhood at predetermined periods, receives beacon signals from other wireless communication apparatuses(ST4)to obtain a grasp of the wireless communication apparatuses communicable with, calculates the reception slot of the wireless communication apparatus from the received beacon information, sets a reception slot so as not to collide with the set situation thereof(ST7), and autonomously engages in time division multiplex communication with other wireless communication apparatuses located at the neighborhood is

formed.

[SELECTED DRAWING] Fig. 7